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the regret of the Section, he was unable to be present.

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*A NEW METHOD OF SYNCHRONIZING
STRATA.**

FOR nearly a century it has taxed stratigraphical geologists to the utmost to devise some rational and practical method by which the strata of the globe, the exposed sections of which are not visibly connected, can be brought into synchronous juxtaposition. Various schemes have from time to time been proposed, tried and abandoned. While it is a simple matter to correlate two rock outcrops which are not far away from each other, the difficulties rapidly increase with distance and by existing standards the determination of the exact equivalents finally become almost impossible.

It is the special province of geological correlation to establish a general chronologic sequence for rock successions more or less widely separated geographically. The main features of some of the more important standards of comparison that have been adopted or are being used may be briefly considered, their scope defined and their limitations noted. These methods fall into two main categories: (1) the strictly physical, and (2) the biological. Of these the latter have, for many years, been most widely followed. At the present time the former are beginning to assume much greater prominence than ever before.

So profound an influence have the organic remains entombed in the rocks had on correlation problems that it has only been very recently that the inherent weaknesses of this criterion has begun to be appreciated. The advantage of the physical

method over the biological is indicated by the remark made lately by McGee that "Nearly as much information concerning the geological history of the Atlantic slope has been obtained from the topographic configuration of the region within two years as was gathered from the sediments of the coastal plain and their contained fossils in two generations."

Indeed, for more than a score of years that branch of geology called stratigraphy has been practically at a standstill. Its methods are the same that were used 50 to 75 years ago. However, the science of geology as a whole has made gigantic strides. Within the last two decades several entirely new branches have sprung into existence. New and refined methods of working have been formulated. With all this activity going on about it, stratigraphy itself has been at last provided with new weapons of offense and defence, and is beginning to experience a revival that is surely destined to restore its old time prestige.

The scope of the purely physical criteria of correlation and of geological classification as set forth in late years appears to have been generally overlooked. Attention needs to be called only to a few of these. Irving and Van Hise have formulated admirable methods of correlation, in which organic remains are left entirely out of consideration. McGee and his colleagues have, by purely physical methods, attacked the unfossiliferous deposits of the coastal plain and then have applied the same methods successfully to the fossiliferous terranes. Davis and others have rejuvenated the old methods of stratigraphical continuity and lithological similarity, by making possible a system of correlation by geographic forms, and broad areas are now being geologically mapped by this method alone. All of these methods are more or less complex and not simple, but they demonstrate that newer and more natural ways are rapidly replac-

* Abstracted from a paper read before the Academy of Sciences of St. Louis.

ing the older and more artificial ones, and that there is ample hope for devising physical means of correlation that are more in harmony with the real nature of the problems involved.

Still more recently it has been suggested that the real basis of geological correlation should be found in the causes giving rise to and governing sedimentation. This involves primarily a classification founded upon mountain-making movements. It is proposed, therefore, to emphasize this factor as fundamental in the marking off of the leading subdivisions of geological time, and to define general stratigraphical succession in accordance with the cycles of orogenic development, calling the classification or fundamental principle of correlation a systematic arrangement by mountains, or orotaxis. It is believed to overcome many of the difficulties that are usually encountered in correlation, in that it enables successions of strata to be paralleled not only in provinces whose geological history has been similar, but in those in which it has been very different.

CHARLES R. KEYES.

CURRENT NOTES ON PHYSIOGRAPHY.

THE ROCKY MOUNTAIN FRONT.

MONOGRAPH XXVII., U. S. G. S., on the Geology of the Denver Basin in Colorado, by Emmons, Eldredge and Cross, gives some account of physiographic features amid its detailed description of geological structures. The mountain front, when seen from a distance, rises as if from the sea in a continuous but rugged slope. A closer examination shows that, after reaching a certain height, the frontal spurs ascend more gradually to the main crest of the range, which lies unexpectedly far back. The upper valleys are wide open, but descend into deep and narrow gorges towards the 'shore line.' This is taken to indicate a revival of stream action by up-

lift, after an advanced stage of denudation had been reached when the region stood at a lower level. The hog-back ridge of the upturned foot-hill strata (Dakota), with the longitudinal subsequent valleys behind it, is generally even and continuous. Zigzag turns are formed on occasional folds; lapses of the ridge are noted at Golden and Boulder, where the Dakota sandstone was not deposited. The moderate relief of the Plains is shown to result from extensive denudation; the uppermost members of the series are broadly stripped off, leaving wide valleys between uplands and mesas of significant relief to the cross country traveller, but broadly plain in comparison to the bold mountain front.

CASTLE MOUNTAIN, MONTANA.

CASTLE Mountain is an outlying member of the Front range of the Rocky mountains in Montana, between the Missouri and Yellowstone rivers. It is described by Weed and Pirsson (Bull. 139, U. S. G. S.) as a 'dissected volcano,' although the considerable cone that must have once risen here (as attested by lava flows and tuffs) has been almost completely denuded, and the existing mountain of massive granite is hypothetically represented as of laccolitic structure in the corrugated beds of the heavy stratified series; the granites being older than the effusive materials. As is so generally the case in the Rocky mountains, moderate deformation occurred after extensive denudation of the corrugated strata, and considerable stratified deposits now mark the sites of lakes thus formed; the plains of Lake Smith, west of Castle Mountain, being the local illustration of this geographical element. The volcanic eruptions were antecedent to the lacustrine period, as the lake beds consist largely of stratified volcanic tuffs. Glacial action is indicated by well marked moraines which are referred to two epochs.